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FY 2003

Budget in Brief

for the
Office of Fossil Energy
U.S. Department of Energy



The FY 2003 Fossil Energy Budget Request

Introduction

America's best prospects for greater energy security lie in our ability to use our most abundant indigenous energy resources more efficiently, affordably, and without compromising the quality of our environment.

The United States is blessed with huge supplies of coal – the energy content of America's recoverable coal far exceeds the energy value of all the oil in the Middle East. Within our borders also reside vast quantities of natural gas – and if we can tap such unconventional gas supplies as deep gas and hydrates, our already large gas potential could expand many fold. Even large supplies of crude oil remain – not only in unproduced regions such as in Alaska and offshore but in existing lower-48 fields where, in some cases, conventional technology has recovered only a third or less of the original oil.

America's energy security historically has not been constrained by lack of natural resources – only by lack of technology to produce and use these resources to their fullest energy potential.

This situation is changing, however. Investments in new technology by both the private sector and government, often in partnership, are reshaping the way we think of, and rely on, fossil fuels. For example:

- Power generators can now turn coal into a gas that burns as cleanly as natural gas and use the coal-derived gas to generate electricity with unprecedented efficiencies;
- Scientists are discovering ways to capture and store carbon gases from fossil fuel combustion, preventing them from entering the atmosphere and contributing to the greenhouse effect;
- Fuel cells – the product of more than a quarter century of joint government-industry development – are now entering their first market applications, and recent advances in solid state engineering have raised prospects for dramatic cost reductions;
- Improvements in underground imaging systems now reveal oil and gas deposits that would have gone unnoticed a few years ago. Advanced drill bits, some hardened by microwaves, now bore much faster and at lower cost. New downhole treatment processes keep older wells producing longer. Improved computer software now helps producers pinpoint where new wells should be drilled to keep oil and gas flowing from existing fields.

The Department's FY 2003 budget request continues to build on these and other advancements. It allocates \$548.2 million for research and development into fossil energy resources and technology (when funding transfers and offsets from prior year balances are included, the total request is \$494.2 million). This request is comparable to the funding level approved by Congress in FY 2001. It is about 13% less than the amount Congress appropriated for FY 2002, due largely to reductions in proposed funding for petroleum and natural gas research.

Ensuring Near-Term Energy Security. Greater energy security also requires the readiness to respond to nearer-term threats. The FY 2003 Fossil Energy budget request also includes funding for the *Strategic Petroleum Reserve* – the Nation's first line of defense against an imminent or actual disruption in commercial oil supplies. President Bush has announced the intent to fill the Reserve up to its full 700 million barrel capacity principally by using exchanges of royalty oil produced from federal offshore leases. The budget request includes funding to maintain the full readiness of the current crude oil inventory and added funding to pay the expenses associated with receiving and storing the additional crude oil from the royalty-in-kind exchange program.

The budget request also fully funds the *Northeast Home Heating Oil Reserve*, another key component of the Administration's near-term energy preparedness posture. Together, the funding for both the Strategic Petroleum Reserve and the Northeast Home Heating Oil Reserve would total \$188.8 million in FY 2003, a 5% increase over FY 2002.

Funding is also requested to continue operating the two remaining commercial oil fields that make up the Naval Petroleum Reserves (NPR-2 in Kern County, CA, and NPR-3 in Natrona County, WY) and for completing the closeout work associated with the 1998 sale of the Elk Hills field. The budget request also includes funding to pay the fifth installment of a settlement with the State of California concerning claims to "school lands" within the Elk Hills field.

When funding offsets and other transfers are included in the budget request, the overall FY 2003 request for Fossil Energy funding totals \$816.0 million, a 6% reduction from FY 2002 but an 11% increase over funding approved in FY 2001.

The following chart summarizes the key elements of the FY 2003 Fossil Energy budget request.

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Fossil Energy R&D			
President's Coal Research Initiative	\$ 268,277	\$ 338,377	\$ 325,600
Other Power Systems (Distributed Power Generation)	<u>51,274</u>	<u>58,124</u>	<u>49,500</u>
Subtotal, Coal and Power Systems	319,551	396,501	375,100
Natural Gas Technologies	43,925	45,200	22,590
Oil Technology	65,095	55,999	35,400
Program Direction & Management Support	84,098	90,373	89,550
Plant & Capital Equipment	3,891	13,450	2,000
Environmental Restoration	9,978	9,500	9,715
Cooperative Research and Development	7,858	8,240	6,000
Import/Export Authorization	2,295	2,400	2,500
Advanced Metallurgical Research	5,214	5,200	5,300
Subtotal, Fossil Energy R&D	541,905	626,863	548,155
Transfers			
- from Clean Coal Technology Previous Balances	-95,000	-33,700	-40,000
- from SPR Petroleum Account (non add)	-12,000	0	0
- from prior year balances	-4,000	-6,000	-14,000
Total, Fossil Energy R&D	442,555	587,163	494,155
Clean Coal Technology (advance appropriations from 1986-93 program)	104,427	42,463	40,000
Strategic Petroleum Reserve			
SPR Facilities Development	157,483	171,908	169,754
SPR Petroleum Account - Oil Acquisition	0	0	11,000
Northeast Home Heating Oil Reserve	8,000	8,000	8,000
Transfers			
- to SPR Facilities Development	-4,000	0	0
- to Fossil Energy R&D	-12,000	0	0
Total, Strategic Petroleum Reserve	149,483	179,908	188,754
Naval Petroleum Reserves			
- Naval Petroleum & Oil Shale Reserves	1,829	17,617	21,069
- Elk Hills School Land Fund	<u>36,000</u>	<u>36,000</u>	<u>72,000</u>
Total, Naval Petroleum Reserves	37,829	53,617	93,069
Alternative Fuels Production (Interest)	-1,000	-2,000	0
TOTAL, FOSSIL ENERGY PROGRAMS	\$ 733,294	\$ 861,151	\$ 815,978

Fossil Energy R&D

The President's Coal Research Initiative

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Clean Coal Power Initiative	0	150,000	150,000
Central Systems R&D			
- Innovations for Existing Plants	19,663	23,500	21,200
- Advanced Systems			
- Indirectly Fired Cycle	5,885	0	0
- Integrated Gasification Combined Cycle	34,337	43,000	40,650
- Pressurized Fluidized Bed Combustion	11,944	11,000	9,100
- Turbines	30,244	18,500	14,000
- Power Plant Improvement Initiative	94,791	0	0
Sequestration R&D	18,363	32,177	54,000
Clean Fuels R&D	22,940	32,200	5,000
Advanced Research	30,110	28,000	31,650
Total, President's Coal Research Initiative	268,277	338,377	325,600

Goal: Create options for continued electricity production from the extensive U.S. fossil fuel resource, ultimately leading to development by 2015 of near-zero emission plants (including carbon) that are fuel flexible, capable of multi-product output, and can achieve efficiencies of more than 60% with coal and 75% with natural gas.

There is no better example of America's energy strength than its abundant coal reserves. One quarter of all the world's known coal supplies are found in the United States. The energy potential of American coal is the equivalent of one trillion barrels of crude oil.

President Bush recognized the value of U.S. coal to the Nation's energy security when he proposed a new vision for clean coal technology and pledged an investment of \$2 billion over the next 10 years to build on the significant technological progress made in recent years. The Department's FY 2003 budget proposal contains the second installment of funding for the President's initiative. It also focuses much of the undergirding coal research program on the President's longer-term clean coal technology goals.

The Clean Coal Power Initiative. This will be the initial step in carrying out the President's commitment. The Department intends to combine the \$150 million appropriated in FY 2002 with the \$150 million requested for FY 2003 and approximately \$30 of available funding from the Power Plant Improvement Initiative¹ into a \$330 million solicitation for industry-proposed, cost-shared

¹ The Power Plant Improvement Initiative was a single competition conducted in 2001 that resulted in 8 projects with a total value of \$111 million and a federal commitment of \$51 million

demonstration projects. Scheduled to be issued on or around February 18, 2002, this first solicitation will focus on rapidly advancing technologies that can be accelerated into the power sector through government-industry partnership projects. Industry sponsors will be required to at least match the federal funding share, and there will be a requirement that royalties from commercially successful technologies be used to underwrite future clean coal research.

The initial round of the Clean Coal Power Initiative will provide the means for advances that have emerged since the last major Clean Coal Technology competition was held nearly a decade ago to clear their final technological hurdles.

These new technologies can play a timely role in the Nation's new energy economy. America's economic growth is increasingly dependent on reliable, affordable electricity. Coal currently supplies more than 50% of the Nation's electric power – including most of our lowest cost power. To meet new environmental standards and keep power costs affordable, the Nation needs a new generation of clean coal technologies, now and in the future.

As the Clean Coal Power Initiative evolves in future years, competitions will likely look toward longer-range concepts. Technology developers will be encouraged to propose projects that advance the state-of-the-technology toward the Department's ultimate objective: a virtually pollution-free, coal-based energy plant.

To prepare for this longer-range clean coal goal, the FY 2003 budget also includes an underlying research program also conducted in partnership with industry. In this program, the focus is on revolutionary concepts that will push the energy efficiencies of future power plants to their maximum levels, turn pollutants into safe, commercially valuable products, and capture and control the release of greenhouse gases – in other words, essentially eliminate the environmental objections to the use of coal.

Central Systems R&D. Central station power plants remain the workhorses of America's power sector; currently, there are more than 375 coal-fired plants in the United States that generate 100 megawatts or more. Even though there is increasing interest in smaller, decentralized power systems, central station power generators will remain the dominant contributors to the Nation's power supply for well into the future.

Innovations for Existing Plants: An important nearer-term element of the Central Systems R&D program is the development of a scientifically sound base of data and technology to understand and reduce air and water pollutants from existing plants.

Public Benefit: The National Academy of Sciences reported upwards of **\$60 billion** in benefits gained from the Office of Fossil Energy's research in air pollution control technology – equivalent to roughly *five dollars for every dollar invested*.

Special attention is being focused on microscopic airborne particles (called PM 2.5), nitrogen oxides, and air toxics (especially mercury). Each represent significant, near-term environmental challenges

for coal plants, and all are likely to be part of a multi-pollutant emission control strategy. Yet, at the present time, the technology to control these pollutants (or their precursor emissions) to the levels anticipated in future regulations is either very speculative, costly, or in some cases, non-existent.

Mercury is likely to be one of the next major environmental challenges for the coal-fired power industry. To meet the 2008 deadline for mercury emission controls (EPA must publish a final rule by 2004), many of the Nation's coal-fired power plants will require new technology. Data collected by the Department in the late 1990s shows that no pollution control system on the market today reduces mercury emissions uniformly across the full range of power plant configurations. Emission controls can vary from 90% to virtually zero.

To develop mercury controls that are more reliable, lower cost, and applicable to a wider range of plant types, the Department has put into place an aggressive technology development program. In 2000, the first near-term projects were selected with a goal of cutting mercury emissions by 50% to 70% by 2005 at one-half or less of today's costs. In 2001, six more projects were added to the program with the longer term goal of 90% emission reductions by 2010.

The initial projects are now producing their first results. In late January, ADA Environmental Solutions and a Wisconsin utility announced that the first full-scale tests of carbon injection showed the capability to remove between 40 and 60% of mercury emissions – especially significant given that the test was performed with western coals which emit the most difficult form of mercury to capture. In FY 2002, short-term testing (3 to 4 weeks in duration) will be completed at three commercial power plants. In FY 2003, the fourth and final short-duration field test will be completed. The next step will likely be longer-duration tests – extending over several months to as much as a year – to gather data on long-term operability and maintenance requirements.

The Department has also made significant advances in recent years to understand the “fingerprints” of the tiny PM 2.5 particles that will also be regulated more tightly in the future. So small that 30 of them laid side-by-side would barely equal the width of a human hair, these particles can be released into the atmosphere from a variety of human activities – power plants are one of many sources.

If future regulations are to be scientifically-sound and cost-effective, much better information will be needed on how and where these particles originate. Toward this end, the Department will deliver a major PM 2.5 characterization report to EPA later this year describing the results of three years of sampling and analysis in the Ohio River Valley. In FY 2003 the Department plans to complete the development of a web-based PM 2.5 information management system that will integrate the air quality data DOE is collecting in the Upper Ohio River Valley into a common data base. The tool will allow federal and state regulators, DOE and other researchers, and the public to access data on air quality in the region and make better decisions on future regulations.

Nitrogen oxide, or NO_x, is also another focus of the Department's research and development. NO_x pollutants – formed primarily during fuel combustion in large utility and industry boilers as well as in cars, trucks and other engines – have declined the least of all the major criteria pollutants over the last two decades. Currently, utilities in 22 eastern states are required to meet NO_x emission limits of 0.15 pounds per million Btu, but power plants in other states may be facing similarly stringent NO_x requirements in the future. The Department has set a goal of developing improved NO_x control systems that can meet or better the 0.15 pound-per-million-Btu standard at costs at least 25% lower than the standard compliance technology available today (selective catalytic reduction).

In FY 2002, pilot scale tests will be completed on two of the five advanced ultra low-NO_x burners now in the Department's development program. In FY 2003, the final advanced NO_x control technologies will complete their pilot scale tests. If test results are successful, the technologies will be ready for full-scale demonstration, and important data will be generated for use in future multi-pollutant control strategies.

Advanced Systems – the Power Plant of the Future. Just a few years ago, the idea that a coal plant could be pollution free, including even carbon emissions, seemed farfetched at best. Today, that view has changed – it now appears likely that if the pace of current development can be sustained, a new type of fossil fueled energy plant can be introduced by 2015 that would have virtually no negative effects on the environment.

This is the goal of the Department's *Vision 21* program. Activities in several program areas within the coal research budget support this goal, as shown in the following chart:

Program Activity (\$ in thousands)	FY 2003 Overall Budget Request	Portion Allocated for <i>Vision 21</i>
Integrated Gasification Combined Cycle	\$ 40,650	\$ 16,334
Pressurized Fluidized Bed Combustion	9,100	495
Turbines	14,000	14,000
Advanced Research	31,650	24,000
Fuel Cells	49,500	11,500
Total, Vision 21 Funding		\$ 66,329

The Department continues to orient a larger number of its power system research efforts toward Vision 21. In FY 2002, the *Pressurized Fluidized Bed Combustion* (PFB) program was recast to focus on alternate technology pathways. Although PFB technology has shown technical promise, new concepts such as combustion hybrids appear to have even more potential and reduced risks. Therefore, the PFB program was refocused on advanced gasification/combustion hybrid systems that could become integral modules in future Vision 21 plants.

In FY 2003, another significant refocusing will be underway in the *Turbine* technology development program. With the successful completion of the Advanced Turbine Systems development effort – which produced two new revolutionary, ultra-high efficiency, low-polluting utility scale natural gas turbines – DOE’s turbine research is being redirected toward the development of a new generation of zero-emission turbines, capable of being fired with coal gas and other gaseous feedstocks. Termed HEET – for “High Efficiency Engines and Turbines” – the new program is being defined this year by industry input and ongoing studies of market applications, public benefits, and technology needs. A report outlining DOE’s intended R&D direction will be published and delivered to Congress in February, 2002.

Public Benefits: If power plant efficiencies can be increased by 50 percent over today’s deployed plants, greenhouse gas emissions could be reduced by more than 340 million tons of carbon per year by 2050.

Next generation central and distributed power systems under developed in the Office of Fossil Energy (including Vision 21) could save Americans nearly \$4 billion per year in the cost of electricity by 2020.

With these programs being redirected and with other ongoing efforts, the Department now has in place a full “breadth” of development efforts for all of the major technology modules likely to make up a future Vision 21 plant. In the FY 2003 and subsequent budgets, projects will be added to increase the “depth” of these research efforts – providing a wider range of technological approaches that will enhance the likelihood of success. Special attention will also be focused on the integration of Vision 21 modules – a non-trivial engineering challenge that will be greatly aided by the development of advanced computational modeling and simulation software.

Sequestration R&D. Carbon sequestration – the capture and storage or recycling of carbon gases – is the fastest growing program area in the Department’s Fossil Energy budget, reflecting President Bush’s emphasis on developing advanced technologies to reduce the buildup of greenhouse gases.

Currently, more than 50 projects are in various stages of development in the Fossil Energy carbon sequestration program – an indication of the progress that has been made since 1998 when the Department provided its first 12 modest grants for “promising ideas” on how to sequester greenhouse gases.

This year the first of these projects will move into early field tests, providing the first “real life” data on whether various proposals for storing carbon gases are, in fact, worth pursuing. For example, in FY 2002 the first full-scale project to sequester CO₂ in unmineable coal seams will take place, along with the first full-scale monitoring and verification of CO₂ injection into a depleting oil reservoir.

The significant increase in funding for FY 2003 (\$54.0 million compared to \$32.2 million in FY 2002) reflects the necessary costs for moving additional, promising concepts from laboratory-scale research into large-scale field tests. New field experiments in terrestrial sequestration, along with additional field tests in geological storage of greenhouse gases, are planned for FY 2003.

A key sequestration initiative in FY 2003 will be the establishment of “regional carbon sequestration networks” – groups of organizations, including state agencies, that would jointly prepare and carry out DOE co-funded sequestration projects suited specifically for certain regions. The projects would involve not only the actual sequestration test but much of the regional policy, regulatory and public communication efforts that will be necessary for sequestration to ultimately be accepted as a viable carbon management tool.

Clean Fuels R&D. The Office of Fossil Energy’s Clean Fuels R&D program is in transition. Historically the program focused largely on methods to convert coal to liquid fuels. Three years ago it was reoriented to include new efforts in reducing sulfur from petroleum and converting natural gas to liquid transportation fuels.

The reduction in the FY 2003 budget request – to \$5.0 million from \$32.2 million in FY 2002 – reflects the Administration’s view that much of the reoriented program was directed at research industry could do on its own.

Rather than concentrating on ways to remove pollutant-forming impurities from gasoline and diesel fuels, the FY 2003 budget request narrows its focus to exploratory research on novel concepts for chemically converting fossil fuel feedstocks into liquids and the development of a novel ceramic membrane that could significantly lower the costs of producing “syngas” for liquids production. If successful, this new membrane might also provide a lower-cost means for producing clean-burning hydrogen.

Advanced Research. As in past budgets, the FY 2003 Advanced Research budget is comprised of two types of activities:

- Crosscutting and applied research that benefits the development of both superclean, ultra-high-efficiency coal-based power systems and coal-based clean fuel systems; and
- Analytical and assessment activities that include technical and economic analyses and international technology and program support.

Crosscutting and applied research. This is the “technology incubation” portion of our power and fuels program – the area where new ideas are generated and studied at sizes ranging from the atomic and molecular scale to the earliest lab-scale prototypes of innovative concepts. From this research has come the “Super 9 Cr Alloy” now used in more than 100 power plants with sales exceeding \$1 billion; new iron aluminide and ceramic filters now being offered commercially; a new type of high-strength stainless steel that makes up a key component of advanced industrial gas turbine; and new carbon fiber molecular sieves that have the potential to separate greenhouse gases from the exhausts of power plants.

In FY 2003 efforts in this area will concentrate increasingly on developing the critical underlying technologies for *Vision 21*. Advanced materials will be especially important; for example, a new molybdenum-silicon alloy under development could help accelerate the development of ultra-high temperature power technologies. The development of new metal oxide and silicon carbide microsensors – considered by many experts to be the new “wunderkinds” of sensor technology – will be included in the increased funding requested for Coal Utilization Science. Work will continue to develop new computational science tools that will allow designers to model future plant configurations on a computer before committing to expensive construction projects.

Research in this area is also supporting innovative ideas for carbon sequestration. In the bioprocessing area, for example, high-tech concepts that mimic natural biological processes, such as photosynthesis, are being studied. Also, fundamental work in mineral carbonation – a promising area in which DOE scientists have made remarkable progress in recent years – will proceed to the point where the technology will likely be transferred to the Carbon Sequestration line program.

Technology Crosscut - Analytical and Assessment Activities and International Support. These ongoing efforts will be funded at approximately the same level as previous years with cooperative activities continuing to support the global deployment of advanced U.S. coal technologies, the analyses of air, water and solid waste issues, and studies to better define the strategic benefits of advanced fossil fuel technology.

Distributed Power Generation Systems

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Fuel Cells			
- Advanced Research	\$ 2,721	\$ 4,000	\$ 3,000
- Fuel Cell Systems (Molten Carbonate/Solid Oxide)	30,172	13,500	10,000
- Vision 21 Hybrids	14,592	13,500	11,500
- Innovative Systems Concepts	<u>3,789</u>	<u>27,124</u>	<u>22,500</u>
Subtotal, Fuel Cells	\$ 51,274	\$ 58,124	47,000
Novel Distributed Generation Concepts	0	0	2,500
Total, Distributed Power Generation Systems	\$ 51,274	\$ 58,124	\$ 49,500

Goal: By 2010 introduce a new all-solid-state fuel cell module with a capital cost of \$400 per kilowatt that will be economically attractive for use in mainstream commercial power markets and as a flexible power source for mobile and military applications. Also in the 2010-15 timeframe, develop fuel cell-turbine hybrid systems that can be integrated into the Vision 21 concept to achieve efficiencies approaching 70 to 80% and near zero levels of pollutants.

The Office of Fossil Energy's *Fuel Cell* program is on the verge of another success. Already, more than 220 “first generation” phosphoric acid fuel cell mini-power plants are operating or on commercial order throughout the world based on technology DOE helped develop in the 1980s. Now the more advanced fuel cells that DOE helped develop in the 1990s are being introduced into

the market. Orders for more than a dozen of the higher temperature molten carbonate fuel cells have been received by FuelCell Energy Inc., and the Connecticut company has broken ground on a 50-megawatt per year manufacturing facility. Siemens Westinghouse, DOE's partner in developing an even higher temperature tubular solid oxide fuel cell system, has announced plans for its commercial manufacturing complex; an initial section of the plant is expected to begin fabricating commercial-scale solid oxide fuel cells in the spring of 2003.

The Department's FY 2003 budget, therefore, will complete the federal role in the development of these two classes of advanced fuel cell technology. Research attention will turn increasingly to the next two major challenges confronting fuel cell technology: (1) significant cost reductions, and (2) the development of fuel cell-turbine hybrids that can push fuel-to-electricity efficiencies to "breakthrough" levels of 70 to 80%.

Cost reduction is necessary for fuel cells to move into mainstream applications. Commercial technologies being offered today and those projected to emerge over the next few years will be among the cleanest and most efficient power sources on earth; yet, because of their high costs, their use will likely be confined to niche markets where a premium can be paid for highly-reliable, high-quality onsite power.

For fuel cells to be competitive with more traditional power sources – such as gas turbines and diesel generators – costs must be reduced by a factor of 10 compared to today's phosphoric acid fuel cells and to a third of the expected market entry costs of the more advanced fuel cells.

To help bring about these dramatic cost reductions, the Department has helped create the Solid State Energy Conversion Alliance (SECA), a group of federal agencies, national laboratories, universities, and fuel cell developers. SECA's goal is to produce a core, solid-state fuel cell module that could be produced at a cost of no more than \$400 per kilowatt.

The key to the ambitious cost reductions will be the development of a compact, lightweight, 5-kilowatt "building block" module that can be mass-produced using many of the same manufacturing advances that have dramatically lowered costs in the electronics industry.

The modularity of the system will permit the 5-kilowatt unit to be clustered into a variety of custom-built stacks for a wide variety of applications, from small portable military power sources to multi-megawatt central generating stations. The system could also be a prime option for powering tomorrow's electric vehicles.

Four industrial teams are now beginning conceptual designs of a SECA module, and one or two additional teams may be selected in FY 2002. The Department also expects to make its first awards in FY 2002 for the underlying "core" technologies that will be important for all of the SECA concepts, e.g., interconnects, seals, sulfur-tolerant catalysts for fuel reforming, power density improvements, etc.

Development of *Vision 21* hybrid technology will also continue in FY 2003. Early modeling and testing to date has shown that integrating a fuel cell and turbine into an efficient power generator is a much more complex undertaking than many people first imagined. Operation of a 280-kilowatt molten carbonate-turbine hybrid in FY 2002 and the start of testing for a 300-kilowatt tubular solid oxide hybrid system will provide important early data that engineers can use to improve the designs of future hybrid systems.

The RAMGEN technology is the focus of the *Novel Distributed Generation* budget request. A RAMGEN power generator is unlike any conventional stationary power concept. It uses ramjet thrust modules—the same basic propulsion system used in high performance aircraft or supersonic missiles – to spin a rotor at rim speeds exceeding 2½ times the speed of sound. These simple thrust modules replace the many complex moving parts in gas turbines and other internal combustion engines. The magnitude of the centrifugal forces generated at supersonic speeds, however, demands advanced designs and high-performance materials.

The developer believes that the engine can be scaled to generate electricity at unit sizes ranging from 750 kilowatts to 40 megawatts – making the technology applicable for a wide range of distributed generation applications. The current prototype is designed to generate from 10 to 15 megawatts. DOE's funding in FY 2003 will support the development and testing of the RAMGEN engine.

Natural Gas Technologies

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Exploration and Production	\$ 13,866	\$ 20,500	\$ 15,450
Gas Hydrates	9,703	9,800	4,500
Infrastructure	7,914	10,050	0
Emerging Process Technology	9,897	2,250	0
Effective Environmental Protection	2,545	2,600	2,640
Total, Natural Gas Technologies	\$ 43,925	\$ 45,200	\$ 22,590

Goal: By 2010 add almost 2 trillion cubic feet per year of additional gas production as a result of technologies and practices from DOE supported research and development.

Natural gas remains one of the Nation's most promising resources for meeting both its energy and environmental objectives. Indeed, nearly 90% of the new power generating capacity planned for the next 20 years is currently projected to be fueled by natural gas. With drilling and production back on the upswing after the depressed conditions of 1998 and 1999, the natural gas industry is entering a period where growth in the demand for its product is likely to be more robust than ever before.

This situation has caused DOE to rethink where its federal dollars for natural gas research should be directed to be most productive. Generally, the reduction in the Natural Gas Technologies budget request for FY 2003 reflects the decision to target funding to those areas where industry clearly is not funding major development efforts on its own, or where a small amount of federal support can

complete high-payoff, multi-year development efforts, or where federal cost-sharing can lead to technologies that can keep gas flowing from domestic wells that otherwise would be shut in.

In *exploration and production*, this means that much of the FY 2003 budget will be directed at completing the final year of development for several advanced drilling and diagnostic tools. For example, in FY 2003, development of a new type of composite drill pipe will be completed. Made of carbon resins similar to those used in the shafts of golf clubs, the drill pipe will be less than half the weight of its steel counterpart, allowing producers to drill greater distances laterally from an offshore platform, for example, or to drill in greater water depths. Similarly, a new ultra-lightweight cement will be readied for commercial introduction in FY 2003 with the first applications likely to be in deep water drilling and production.

Also in FY 2003, development of a high-pressure, jet-assisted coiled tubing drilling system will be completed, providing a new tool for industry to use to drill through dense gas-bearing formations faster and at less cost. A new diagnostic tool that can measure the growth of artificially-induced fractures in a gas field in real time will also be readied for industry use in FY 2003.

As these development efforts conclude, research will continue in areas that offer significant potential for new gas supplies, such as the development of deep drilling technologies for use in the Rocky Mountains, the continued improvement of such revolutionary technologies as laser drilling, the study of high water production problems in many of the tight gas sand formations in the West, and the development of ultra-deep (greater than 16,000 feet) drilling technologies, incorporating advanced coatings and specially hardened downhole “smart” sensors.

Funding will also be provided to continue support of the Stripper Well Gas Consortium, an industry-driven consortium of gas producers, service companies, universities and others that is working with the Department to develop technologies to keep natural gas flowing from low-production wells, most notably in Appalachia, Texas and Oklahoma. This type of consortium funding allows federal research dollars to benefit a large number of companies and produce measurable results in the form of additional domestic gas supplies.

The Department will also use FY 2003 funding to complete its research into “secondary gas recovery.” This research has provided new tools and methods that operators can use to locate and produce natural gas missed by conventional technologies. Federal involvement in this technology development effort has helped revitalize gas production in areas of south Texas and has led to additional commercial production in the Midcontinent and the Gulf of Mexico.

In *gas hydrates* – a potentially huge, but still speculative future gas resource – funding is being scaled back. The proposed level, however, is still sufficient to collect important data on safety and seafloor stability and the role of hydrates in global climate change. Several industry-led field activities are underway to drill into and collect samples of naturally-occurring hydrates from the Alaska permafrost and the Gulf of Mexico. With a limited amount of funding support, the Department can “piggyback” on several of these projects and collect data that can be useful in determining future

research needs.

No funding is requested for *gas infrastructure* projects. Within the last two years, the Department has initiated several projects with industry and national laboratories to develop new tools and techniques for detecting damage and improving the integrity and reliability of the nation's aging natural gas pipeline system. Similar projects focused, in most cases, on shorter-term, safety-related needs is conducted by the Department of Transportation's Office of Pipeline Safety. To provide a better integration of short-term and longer-term research efforts, the Administration proposes to transfer responsibilities for all gas infrastructure R&D to the Office of Pipeline Safety. Also, no funding is requested to continue gas storage R&D, and ongoing projects with funding requirements in FY 2003 may have to be terminated.

No funding is requested for *emerging processing technology*. In prior years, this budget category has supported research on improved methods for extracting fuel-grade natural gas from coal mines. Industry now has the technological foundation to proceed on its own. Also, DOE will conclude its financial support for an international center for information on natural gas technologies which also receives funding from the gas industry.

Activities that can lead to more *effective environmental protection* in gas (and oil) fields are funded as essentially the same level as FY 2002. Within this activity, however, there is a proposed funding shift to support increased technology transfer of practices and processes that can address environmental issues that otherwise could limit gas production from domestic fields.

Oil Technology

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Exploration and Production	\$ 28,088	\$ 32,350	\$ 16,400
Reservoir Management Practices	14,278	12,949	9,500
Effective Environmental Protection	10,513	10,700	9,500
Emerging Processing Technology Applications	2,500	0	0
Ultra Clean Fuels	9,716	0	0
Total, Oil Technology	\$ 65,095	\$ 55,999	\$ 35,400

Goal: By 2010 add more than 1 million barrels a day of domestic oil production as a result of technologies and practices from DOE supported research and development.

Similar to the Natural Gas Technologies program, funding in the Oil Technology program would be redirected in FY 2003 to those areas where industry is not focusing its research attention and where a small amount of federal support could return significant dividends in terms of increased domestic oil production.

Much of the proposed FY 2003 program in *exploration and production* would focus on fundamental research that can be applied across the entire petroleum industry. PRIME – an initiative to support high-risk, fundamental research that could produce revolutionary advances in oil technology – will kick off in April 2002 with a call for proposals and will continue to be supported in FY 2003. General areas likely to be covered under PRIME will be remote sensing and surveying, advanced tools for lower-cost slimhole drilling, remote downhole wireless monitoring, and advanced petroleum recovery technologies.

Public Benefits: The National Academy of Sciences reported economic benefits of **\$4.5 billion** from 1978 to 2000 resulting from the Office of Fossil Energy's investment in advanced oil exploration and production technologies – *a nearly 4 to 1 return* on federal R&D dollars. The investment also resulted in the production of more than half a billion barrels of U.S. oil that might otherwise have remained in the ground.

Also, fundamental geoscience research that can lead to improved methods for determining the fracture characteristics of an oil-bearing formation will continue in FY 2003. The development of novel chemical and advanced thermal methods that can improve enhanced oil recovery from existing U.S. fields will also be continued.

To assist domestic producers apply better *reservoir management practices*, the Department will continue its PUMP initiative. PUMP – for “Preferred Upstream Management Practices” – is a major technology transfer effort, designed to disseminate new technologies, more effective production strategies, and other field management improvements to the Nation's smaller independent companies. In April 2001, the Department announced the first five PUMP projects, then in September, it added four more projects. In FY 2002, a third round of projects will be selected.

Also as a way to keep many of the Nation's aging oil fields in production, the Department will continue its “Technology Development with Independents” program in FY 2003. This program provides grants to the smallest of domestic producers (companies with less than 50 employees) to apply new technologies that might not otherwise be used. This program has produced several remarkable successes – for example, a quadrupling of production from a small stripper well field in Los Angeles through the use of a new acid for well treatment. It has also resulted in more “producer-to-producer” interactions, as companies with successful results are required under the federal grant provisions to share “lessons learned” with producers in similar fields.

Capitalizing on such technology transfer opportunities is a high priority in the FY 2003 Oil Technology budget. This is reflected in the fact that while funding in other oil related areas has been reduced, support for the activities of the Petroleum Technology Transfer Council, and other technology transfer initiatives, remains at essentially the same level as in prior years.

As in the Natural Gas Technologies program, funding is also being requested for *effective environmental protection* activities that relate to oil field operations. Work will be scaled back in risk assessment efforts for exploration and production activities in favor of increased cooperative efforts

with state, tribal, and federal agencies to reduce permitting times for environmental regulations and regulatory processes. New technologies will also continue to be developed to provide more cost-effective environmental compliance options, with a particular emphasis on protecting sensitive environments on federal lands.

Other Fossil Energy R&D

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Program Direction and Management Support	\$ 84,098	\$ 90,373	\$ 89,550 ²
Plant and Capital Equipment	3,891	13,450	2,000
Environmental Restoration	9,978	9,500	9,715
Cooperative Research and Development	7,858	8,240	6,000
Import/Export Authorization	2,295	2,400	2,500
Advanced Metallurgical Research	5,214	5,200	5,300

The FY 2003 Fossil Energy R&D budget also includes *Program Direction* funding for salaries and other expenses for federal and contract employees at Headquarters and at the Morgantown, Pittsburgh and Tulsa offices of the National Energy Technology Laboratory (NETL). In FY 2003, for the first time, all program direction and management support costs associated with the original Clean Coal Technology program (\$14 million) have been combined within the Fossil Energy R&D account.

In FY 2002, the *Plant and Capital Equipment* budget included \$11 million to acquire land at the Morgantown site and begin new building designs and renovations of onsite laboratories. No new funding for these activities is requested in FY 2003.

Funding in the *Environmental Restoration* budget will be used to continue remediation efforts at several former field test sites and to upgrade worker health and safety conditions at NETL and the Albany Research Center (ARC). In FY 2003, a series of lead and asbestos abatement actions will be completed at NETL and ARC, and a number of fixes will be made at the Pittsburgh and Morgantown sites to improve indoor air quality.

In addition, the budget includes funding for *Cooperative Research and Development* projects at the University of North Dakota Energy and Environmental Research Center and the Western Research Institute. These projects receive at least 50% of their funding from private sector research organizations.

Our budget also supports *advanced metallurgical research* at the Albany Research Center in Oregon. Since it transferred to DOE, ARC has become increasingly involved in our Vision 21 program and in addressing other materials-related challenges of the energy industry. A major effort in FY 2003 will be to complete an analysis of the mechanisms that degrade refractory materials that line coal

² Includes \$14.0 million transferred from balances available in the Clean Coal Technology Program for program direction.

gasifiers. ARC has also emerged as a premier research installation for research into mineral carbonation – a technique for converting CO₂ into an environmentally-benign solid. In FY 2003, the Center will construct and operate a 5-pound-per-hour benchscale mineral carbonation test unit.

The budget also contains funding to conduct regulatory functions associated with the *import and export of electricity and natural gas*. The Office of Fossil Energy is responsible for authorizing the export of electricity, the issuance of permits for electric transmission facilities at our international borders, and for authorizing natural gas imports and exports under Section 3 of the Natural Gas Act of 1938.

Clean Coal Technology

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Deferral of Prior Year Funds	\$ -67,000	\$ -40,000	\$ 0
Previously Deferred Budget Authority	171,427	82,463	40,000
Transfer to Fossil Energy R&D	<u>-95,000</u>	<u>-33,700</u>	<u>-40,000</u>
Total, Clean Coal Technology	\$104,427	\$ 42,463	\$ 0

This budget category allocates funding advance appropriated for the 1986-93 Clean Coal Technology Program, which funded 38 active projects with a total value of \$5.2 billion and a federal funding share of \$1.8 billion. (It should not be confused with President Bush's Clean Coal Power Initiative described earlier.)

Of the 38 projects jointly funded by government and industry, 23 have achieved commercial success, either through replication of the technology or the continued privately-financed operation of the original project.

Seven projects remain in various stages of design, construction or operation (four others are in the final reporting phase), but only two projects – the Kentucky Pioneer coal gasification combined cycle project and the CPICOR advanced iron making/power generation project – have federal funding obligations remaining.

Another Clean Coal Technology project milestone will be achieved this spring when the 300-megawatt JEA circulating fluidized bed combustor project begins operations in Jacksonville, FL. This will be the largest such fluidized bed combustor in the world and with its inherent pollution reduction capabilities and JEA's installation of additional emission controls, it will be one of the world's cleanest coal-burning facilities.

The Strategic Petroleum and Northeast Home Heating Oil Reserves

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Storage Facilities Development and Operations	\$ 140,672	\$ 154,009	\$ 154,856
Management	16,811	17,899	14,898
SPR Petroleum Account	<u>-16,000</u>	<u>0</u>	<u>11,000</u>
Subtotal, Strategic Petroleum Reserve	141,483	171,908	180,754
Northeast Home Heating Oil Reserve	8,000	8,000	8,000
Total, Strategic Petroleum & Northeast Home Heating Oil Reserves	\$ 149,483	\$ 179,908	\$ 188,754

Goal: Fill the Strategic Petroleum Reserve up to its maximum capacity and maintain it in a state of readiness to supply oil at a sustained rate of 4.4 million barrels per day for 90 days within 15 days notice by the President. Maintain the Northeast Home Heating Oil Reserve with the capability to supply 2 million barrels of heating oil within 2 days of a Presidential directive.

The National Energy Policy has identified both the Strategic Petroleum Reserve and the Northeast Home Heating Oil Reserve as key response tools for the President to use in protecting Americans from imminent or actual disruptions in energy supplies.

In November 2001, President Bush announced his intent to fill the Strategic Petroleum Reserve up to its full 700 million barrel capacity. On January 22, 2002, the Department began the first stage of the President's plan, joining with the Minerals Management Service (MMS) to solicit offers from industry to exchange 22 million barrels of royalty oil produced from Federal leases in the Gulf of Mexico. Offers are due on February 5, 2002.

The 22 million barrels of royalty oil will be produced over a year beginning this April at a rate equivalent to 60,000 barrels per day. Ultimately, the Energy Department and MMS hope to increase the "royalty-in-kind" transfer volumes later this year. Should this occur, both agencies would issue further sets of coordinated solicitations for the additional production. The agencies also anticipate future solicitations next year and beyond. Ultimately, as much as 108 million barrels could be added to the Reserve through the Royalty-in-Kind program.

As a result of the President's action, the FY 2003 budget contains \$11 million in the SPR Petroleum Account to pay the incremental costs of terminalling, transportation, power and third party inspections associated with the added fill.

The budget request also includes \$15 million in the Storage Facilities Development and Management account to continue treatment of the existing SPR crude oil inventory to reduce vapor pressure. In FY 1993, the Department discovered that the migration of gases from surrounding salt

formations and natural geothermal heating were causing a buildup of vapor pressure in the stockpiled crude oil. A major “degassing” operation and the installation of heat exchangers took place from FY 1995 to FY 1997; however, it has become apparent that renewed gas intrusion will require a continuous vapor pressure mitigation program. In November 2001, a contract was awarded to construct a degas plant. Continuous removal of excess gas from the SPR crude oil inventory will begin by May 2004.

The Management line in the Strategic Petroleum Reserve budget shows a \$3.0 million savings compared to the previous year due primarily to the Reserve’s aggressive efforts to streamline management and operations functions.

The Department is scheduled to issue a new solicitation for a management and operating contractor for the Reserve by the end of March 2002, with the new contract to be in place by April 2003.

The *Northeast Home Heating Oil Reserve* is fully stocked and ready for emergency use. Commercial terminals in New Haven, CT, Woodbridge, NJ, and Providence, RI, are under federal lease and currently hold 2 million barrels of home heating oil that could be released to the market to counter a sudden fuel emergency. Although it now appears likely that the Reserve will not be called on during the 2001-02 heating season, the Department has in place a new web-based “real-time” auction system that prospective heating oil buyers would access in the event a drawdown is necessary. Development of this system was a key “e-government” initiative undertaken by the Office of Fossil Energy in response to the President’s Management Agenda.

In April 2002, a request for proposals will be issued for the continued operations of the Northeast Home Heating Oil Reserve. The new contract is scheduled to commence on September 1, 2002.

The Naval Petroleum Reserves

(\$ in thousands)	FY 2001 B/A	FY 2002 BA	FY 2003 Cong. Request
Naval Petroleum Reserves			
- Production Operations	\$ 2,500	\$ 2,535	\$ 2,550
- Environmental Restoration	3,100	2,494	2,820
- Rocky Mountain Oilfield Testing Center	4,596	3,000	3,000
- Management	<u>16,683</u>	<u>14,588</u>	<u>12,699</u>
Subtotal, Naval Petroleum Reserves	26,869	22,617	21,069
Use of Prior Year Funds	<u>-25,050</u>	<u>-5,000</u>	<u>0</u>
Total, Naval Petroleum Reserves	\$ 1,829	\$ 17,617	\$ 21,069
Elk Hills School Lands Fund	\$ 36,000	\$ 36,000	\$ 72,000

The FY 2003 budget continues to carry out the changes that have occurred within the Naval Petroleum and Oil Shale Reserves functions and organization since passage of the National Defense Authorization Act for FY 1996.

The Elk Hills oil field, the largest of the Naval Petroleum Reserves, was sold on February 5, 1998. Administrative jurisdiction for the Naval Oil Shale Reserves #1 and #3 was transferred to the Department of the Interior for future leasing activities. The third oil shale reserve, NOSR #2, an undeveloped tract in Utah, was transferred to the Ute Indian Tribe in January 2000.

Therefore, the FY 2003 budget contains funding for the three responsibilities that remain: oversight of commercial leases at the Naval Petroleum Reserve #2 in California, operation of the Naval Petroleum Reserve #3 stripper well field in Wyoming, and management of the Rocky Mountain Oilfield Testing Center co-located on the NPR #3 property.

Royalty receipts from the Naval Petroleum Reserve #2 in California are expected to total \$2.0 million in FY 2003, assuming favorable product prices, while production of the Naval Petroleum Reserve #3 is projected to generate gross revenues of \$5.2 million.

Funding is also included in the budget request to complete the closeout work associated with the sale of Elk Hills. Reservoir engineering analyses still must be completed to determine final equity percentages, legal support remains necessary to conclude sale-related issues, and certain environmental remediation and cultural resource activities remain the responsibility of the federal government as a result of the Elk Hills sale agreement.

The FY 2003 budget also includes the government's required payment to the *Elk Hills School Lands Fund* as a result of a Settlement Agreement reached with the State of California on October 11, 1996. Under this agreement, which resolved longstanding State claims to two parcels of land ("school lands") within the Elk Hills field, the federal government must pay nine percent of the net proceeds from the Elk Hills sale to the State. The current estimate of the net sales proceeds is \$324 million, of which \$298 million has already been deposited into a contingent fund in the Treasury.

Through FY 2002, three installments of \$36 million each will have been paid. A fourth installment was advance appropriated in FY 2002 to be payable in FY 2003. The FY 2003 budget request contains \$36 million for the advanced appropriations as well as \$36 million for the fifth installment. Once all divestment related costs have been paid and the total payment to the State has been calculated, the final two installments will be paid in equal amounts in years six and seven.